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Pre-inoculation and Field Inoculation

FS 601



Cooperative Extension Service
U. S. Department of Agriculture
South Dakota State University

Pre-inoculation and Field Inoculation

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The ability of alfalfa, clover, beans and other legumes to enrich the soil in which they are grown has been known since ancient times. Less than 100 years ago it was discovered that a certain kind of bacterium now called rhizobium, growing in the roots, enabled the plant to use air nitrogen as well as soil nitrogen. These bacteria grow in the roots in structures called nodules in a close association with the plant. It is the relationship of the plant and bacterium working together that uses nitrogen gas. The results are thriftier plants and increased yields.

The results of many tests show that it pays to add bacteria when planting legumes, as the native bacteria are often inadequate or not present in the soil. One Wisconsin study, for example, showed that only one quarter of the fields tested had good effective legume bacteria for soybeans. Only if planting follows a crop of the same legume that was effectively nodulated by a year or two can we assume that sufficient effective bacteria are in the soil.

The Correct Bacteria

Not just any bacterium can team up with any legume. Only members of the bacterial genus *Rhizobium* can enter the roots and cause the plant to form nodules. Furthermore, the correct species of this genus must be present for each species of legume. For example, *Rhizobium trifolii* is the proper partner for true clovers like *Trifolium incarnatum* (crimson clover). The bacteria and plants are even more selective in that only certain strains of the correct species are effective. In other words, only certain strains can work with the plant to "fix" or use atmospheric nitrogen. For this reason, legume seed are manually inoculated with the proper strain. Inoculation by wild rhizobia in the soil is not

Pre-inoculated alfalfa and soybean seed is on the market. But you may be paying for something you're not getting. To be assured of effective nitrogen fixation, you should inoculate your legume seed when you plant it.



Soybean root showing good nodulation. The nodules contain a type of bacterium that enables legumes to use free nitrogen as well as soil nitrogen in plant growth, with the result of increased crop yields at harvest.

very dependable for effective nodulation and nitrogen fixation.

Enough Bacteria

In addition to having the right rhizobium for the right legume, there must also be adequate numbers of the bacterium present in the root zone when the seedlings are developing. Only a few of the many bacteria that try are successful in penetrating root hairs and causing the formation of nodules. Here again, if an effectively nodulated crop of the same species of legume has been grown on the field within the last year or two, sufficient bacteria of the correct type will probably be present.

Is Pre-inoculation The Answer?

About 1958, a major seed company developed a process for pre-inoculation of the seed of some small seeded legumes. This is done at the time of seed processing and bagging for sale. The inoculum is applied as massive numbers of bacteria to large batches of seed at one time. This inoculum, though the cells would die eventually, was supposed to provide such a large number of cells per seed that enough would be alive to be active at planting time.

SDSU researchers tested alfalfa seed pre-inoculated by several firms. Some of the plants from these seed were well nodulated and some were not. Also, we were able to demonstrate no viable bacteria on some of the seed just hours after inoculation. None of the inocula lasted as long as indicated by the expiration date on the tag.

Under the best storage conditions of the seed, the longest period the inoculum survived and gave effective nodulation was two months. Some of the inoculants were not this good.

Experiment station and USDA laboratories in this country, Canada,

and Australia have tested many pounds of pre-inoculated legume seed for the effectiveness of pre-inoculation.

The concerns are, "Do the bacteria survive long enough on the seed? Are the bacteria on the seed an effective strain? Is there sufficient inoculum on the seed when it is planted so that nodules will develop and nitrogen fixation occur?" If these concerns are not met, the farmer is paying for something he is not getting.

The results from the tests conducted in the Bacteriology lab at SDSU agree well with those from most other labs. We tested alfalfa seed which had been treated with pre-inoculants from three firms. In these trials, none of the batches of seed had enough bacteria after two months of storage under refrigeration for effective nodulation. When the seed was stored at room temperature or under variable temperatures as you would find in a warehouse in the spring, survival of the bacteria was even less. Only seed from one company yielded nodulated plants when planted after two months' storage.

Some states ban the sale of pre-inoculated seed of some crops. All the available evidence indicates that pre-inoculants have not improved since the first years of sale of the

seed. Reports from experiment stations and commercial labs say about the same things they said ten years ago: **To be worthwhile, pre-inoculated seed must be planted as soon as possible.**

In the last few years pre-inoculated soybean seed has been placed on the market, and much of it sold. These seeds have not been tested in South Dakota, but the reports from other labs indicate that this seed may be inadequately inoculated, and that by the time the seeds are planted there are not enough bacteria surviving to cause nodulation.

What Then Should Be Done?

It appears that pre-inoculants for alfalfa and perhaps for clover can be beneficial if the seed can be planted within two months after inoculation. This is seldom possible, as seed is processed in midwinter. Even if it is possible to plant within two months, it may be of little real value because 50 to 75 percent of the effective nodulating power of the pre-inoculant may be lost under the very best storage conditions in this time.

With soybeans it appears that none of the present pre-inoculation processes is worthwhile.

To be assured of good nodulation and subsequent nitrogen fixation, a farmer should inoculate his legume seed at the time of planting.

Commercial inoculants from reputable firms do a good job of forming nodules and helping the plant fix nitrogen when the inoculum is fresh and the directions for inoculation are followed.

It must be remembered that this inoculum consists of billions of living bacteria and that they must be alive when placed in the soil or they will do no good. These conditions are met by most of the peat base inoculants on the market now.

Some of the bacteria in the peat die during storage, but this is provided for. The inoculum material contains many more bacteria than are needed, so that many of them can die and still leave enough for a good inoculation. The inoculum must be used within the time specified on the package.

It is important to watch for several things when buying an inoculum. The inoculum must be for the correct crop plant, alfalfa inoculum for alfalfa and soybean inoculum for soybeans. The inoculum must have this year's date on it. You should watch out for inoculum that was stored in a bad place such as a store window or another place where it is not cool.

It pays off in increased yields to inoculate legume seed. But it is still best to mix the inoculum and seed in the field just before planting.

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